Published in final edited form as:

Addiction. 2012 July ; 107(7): 1263–1272. doi:10.1111/j.1360-0443.2012.03793.x.

MULTI-LEVEL ANALYSIS OF ALCOHOL-RELATED INJURY AND DRINKING PATTERN: EMERGENCY DEPARTMENT DATA FROM 19 COUNTRIES

A research report from the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP), the WHO Collaborative Study on Alcohol and Injuries, and the National Institute on Alcohol Abuse and Alcoholism (NIAAA) Collaborative Study on Alcohol and Injuries, Cheryl J. Cherpitel,

Alcohol Research Group, 6475 Christie Avenue Suite 400, Emeryville, CA 94608 USA

Yu Ye,

Alcohol Research Group, 6475 Christie Avenue Suite 400, Emeryville, CA 94608 USA

Jason Bond,

Alcohol Research Group, 6475 Christie Avenue Suite 400, Emeryville, CA 94608 USA

Guilherme Borges,

Universidad Autonoma Metropolitana, Instituto Nacional de Psiquiatria, Tlalpan, Mexico DF, MEXICO

Patricia Chou,

National Institute on Alcohol Abuse and Alcoholism Rockville, MD, USA

Per Nilsen,

Linköping University, Linköping, SWEDEN

June Ruan, and

National Institute on Alcohol Abuse and Alcoholism, Rockville, MD, USA

Xiaojun Xiang

Central South University, Changsha, Hunan, CHINA

Abstract

Aim—While drinking in the event is an important factor in injury occurrence, pattern of usual drinking may also be important in risk of injury. Explored here is the relationship of an alcohol-related injury with individual usual drinking pattern.

Design—Alcohol-related injury is examined using Hierarchical Linear models, taking into account individual usual volume of consumption over the past 12 months, as well as aggregate-level detrimental drinking pattern (DDP) and alcohol policy measures.

Setting—Data analyzed are from emergency departments (EDs) in 19 countries, comprising three collaborative studies on alcohol and injury, all of which used a similar methodology.

Participants—The sample consists of 14,132 injured drinkers across 46 ER studies.

No conflict of interest

Presented at the Research Society on Alcoholism annual meeting, Atlanta, GA, June 25-29, 2011

Measurements—Alcohol-related injury was measured, separately, by any self-reported drinking prior to injury, a blood alcohol concentration (BAC) $\geq .08$, and self-reported causal attribution of injury to drinking.

Findings—While individual usual volume strongly predicted an alcohol-related injury for all three measures, usual drinking pattern also predicted an alcohol-related injury (controlling for volume), with episodic heavy and frequent heavy drinking both more predictive of alcohol-related injury than other drinking patterns. When individual usual volume and drinking pattern were controlled, DDP was no longer a significant predictor of alcohol-related injury. Alcohol policy measures were predictive of both BAC and causal attribution (the stronger the policy the lower the rates of alcohol-related injury).

Conclusions—Volume of alcohol typically consumed and occurrence of heavy drinking episodes are independently associated with incidence of alcohol-related injury. The stronger the anti-alcohol policies in a country, the lower the rates of alcohol-related injury.

INTRODUCTION

While emergency department (ED) studies have found strong associations between alcohol and injury, the magnitude has not been homogeneous across sites, studies, and countries and societal-level variables have been found to account for some of the observed heterogeneity. A multi-level analysis of data from six countries found that the likelihood of injury, given a positive blood alcohol concentration (BAC) or self-report acute drinking, was lower for heavier drinkers compared to lighter drinkers, but was greater in those societies with higher levels of detrimental drinking patterns (DDP) (1), and increased separately with usual volume and heavier drinking (2). A meta-analysis of alcohol-related injury among non-heavy drinkers in these same data found that frequency of drinking had the largest effect size, although heavy drinking, controlling for frequency, was also significant, but the effect size was not homogeneous across studies (3).

These findings suggest that while the amount of drinking on any particular occasion is an important risk factor in injury occurrence, pattern of usual drinking may also be important. A study of ED patients in Australia found that after adjusting for the main effect of acute alcohol intake on injury, regular alcohol intake, even at high usual daily levels, carried lower risks of injury than abstinence (4), while data from a Swiss ED found that at the same level of last-24 hour drinking prior to injury, risk of injury was greatest for those who usually drank little, but on occasion drank heavily (5). A multilevel analysis of ED data in 16 countries found patients' individual volume of alcohol a significant predictor of alcohol-related injury, with studies with higher overall average consumption reporting a higher rate of alcohol-related injury (6). Controlling for study volume, DDP was found to be a significant predictor of variation across studies for both BAC and self-report. The interaction between acute intake and frequency of heavy episodic drinking occasions or volume of drinking has not been examined, and may account, in part, for the heterogeneity found in the association of both acute drinking and usual drinking pattern and risk of injury across ED studies.

The present study extends earlier analysis of alcohol-related injury (6) by including more restrictively defined alcohol-related injury measures (BAC $\geq 0.08\%$) and patient causal attribution of injury to their drinking. Specifically, addressed here are the following research questions: 1) Is individual usual drinking pattern associated with alcohol-related injury, controlling for individual volume of alcohol consumed over the past 12 months? 2) Is regional DDP associated with cross-study variation in alcohol-related injury, controlling for both individual volume, as well as total volume of alcohol consumed over the past 12 months at the regional level? 3) Is regional DDP associated with alcohol-related injury,

controlling for individual usual drinking patterns? 4) Is regional alcohol policy (drink-driving and alcohol access) associated with cross-study variation in alcohol-related injury, controlling for total volume of alcohol consumed within each study and regional DDP?

METHODS

Samples

Data analyzed here include 46 ED studies from 19 countries comprising the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP), and the WHO and NIAAA Collaborative Studies on Alcohol and Injury (Table 1). All studies used a similar methodology developed by Cherpitel (7), and most represent a distinct country or region within a country.

In all studies, probability samples of patients 18 years and older were obtained by approaching consecutive arrivals to each ED, with equal representation of each shift for each day of the week (reported elsewhere) (6). Following informed consent, interviewers obtained an estimate of BAC and administered a 25-minute structured questionnaire. Completion rates averaged 66% for the ERCAAP studies, 91% for the WHO studies, and 81% for the NIAAA studies. Data in the WHO and NIAAA studies included only injured patients who arrived at the ED within six hours following the event, so analyses are restricted to this group of patients.

Outcome Measure - Alcohol-related injury

- i. *Acute intake*, which is the patient self-report of *any* alcohol consumption in the six hours prior to injury, as used in prior analyses (6, 8). Absent a valid acute alcohol use measure in differentiating injuries caused by alcohol from injuries that happen to occur after drinking, two others measure were used to approximate an alcohol-related injury.
- ii. *BAC 0.08%* which is the legal intoxication level used in the U.S. (for operating a motor vehicle), and is higher than legal BAC levels used in most of the other countries (3, 6).
- iii. *Causal attribution* of injury to alcohol which is a subjective measure of a patient's attribution of injury to their drinking by acknowledging that their injury would not have happened had they not been drinking. Those who answered "not sure" or missing on the causal attribution question were coded as "not alcohol-attributed". Sensitivity analysis was performed coding these individuals as positive, with no differences found.

Predictor Variables

Individual drinking measures—Two measures were used to predict the likelihood of alcohol-related injury among injured patients: *overall volume* of consumption and *usual drinking pattern*, both over the past 12 months. Consumption was measured by the total volume consumed for all alcohol beverage types (wine, beer and spirits combined), derived from questions regarding self-reported usual quantity and frequency of drinking. In most of the ERCAAP studies, the usual quantity of drinking was obtained from the usual number of size- and strength-adjusted drinks for each beverage type, summed across types. For the WHO and NIAAA studies, and some of the ERCAAP studies, quantity questions were asked separately for specific beverages and drink sizes. Estimates of usual quantity were then derived by taking the maximum of the beverage-specific quantities for those reporting more than one beverage. Overall volume of alcohol consumption was estimated in standard drinks, each containing 16 ml of pure ethanol.

Individual drinking pattern was constructed from a series of questions related to the self-reported frequency (frequent, defined as weekly; occasional, as < weekly) of usual drinking and frequency of heavy drinking, defined by five or more drinks a day (5+). The frequency of the 5+ measure was based on summing the frequencies of 5–11 and 12+ drinks/day. A pattern measure was developed into five mutually exclusive categories as follows: 1) occasional light/non-heavy (drinks < weekly/never 5+), 2) frequent light/non-heavy (drinks weekly/never 5+), 3) occasional light/occasional heavy (drinks < weekly/5+ < weekly), 4) frequent light/occasional heavy (drinks weekly/5+ < weekly), 5) frequent heavy (5+ weekly).

Study-level aggregate measures—Four study-level aggregate measures were used to predict cross-study variation in rates of alcohol-related injury; two related to drinking (*study-level average 12-month volume* of consumption, for drinkers only, and *regional DDP*) and two regarding alcohol policy (one related to *driving* and the other to *access*), as suggested from prior analyses (3, 6). The two aggregate drinking measures are the counterparts of the two individual-level drinking measures of 12-month volume and pattern, respectively. The DDP measure is an indicator of the “detrimental impact” on health and other drinking-related harms at a given level of alcohol consumption, developed from aggregate survey data or key informant surveys for a number of countries around the world (9, 10) (see Table 1).

The two study-level alcohol policy predictors are both composite measures constructed from four indicators, the data for which were obtained for the time period during which the respective ED data were collected. Indicators for driving-related alcohol policy were: legal intoxication level for driving, random breath testing, sanctions against driving under the influence (DUI), and open container laws. Indicators for alcohol access policy were: legal drinking age, off-premise sales restrictions, bar open hours and sanctions serving minors. Each indicator was coded at three levels (−1, 0 and 1) with higher values indicating more restrictive policy control. Dichotomous measures (e.g., open container laws) were coded as −1 and 1. The final alcohol policy measures were each constructed, separately, as a summed scale, which assumes equal weights for each item in each scale (see Table 1).

Analysis

Multi-level analysis (also known as random coefficient modeling) was used to examine individual and study-level aggregate predictors of alcohol-related injury among current drinking injured patients (i.e., those who reported consuming any beverage containing alcohol in the last 12 months). Injury patients, clustered within each study, are considered level-one data and studies level-two data. As the three outcome measures of alcohol-related injury are dichotomous, hierarchical logistic regression models were fitted with the likelihood of alcohol-related injury predicted by individual-level drinking measures, with cross-study variability in log odds of alcohol-related injury predicted by study-level aggregate measures. Only the intercept of the logit model was allowed to vary across studies (random intercept model). All models were estimated using HLM version 6.02 (11).

When individual-level volume of consumption was used as a predictor, it was log-transformed and then centered within study context (CWC), using the difference between the variable and its study mean as the predictor (12). When the aggregate study-level average log volume of consumption is entered, the coefficient for individual-level consumption is interpreted as the pooled within-study effect of volume, while the coefficient of study-level consumption is interpreted as the effect of aggregate volume across studies.

Multiple models were fitted by incrementally including individual- and aggregate-level predictors for each of the three measures of alcohol-related injury, allowing for an

examination of how the effect of one variable changed when others were entered. Values of BAC and causal attribution measures were missing in some studies, so results presented across the three measures of alcohol-related injury were not based on exactly the same set of studies. This is noted in the tables and sensitivity analyses were performed on only those studies which had data on all three measures to assess robustness of findings.

RESULTS

Table 1 shows the 46 studies in the combined dataset, study sample size of those arriving within six hours of the injury event, and percentage of current drinkers within each study. Also shown in Table 1 is the proportion of alcohol-related injury according to the three measures: self-report of any drinking within six hours prior to injury, BAC $\geq 0.08\%$, and report of causal attribution of injury to alcohol. The prevalence of the drinking pattern categories and values of the three aggregate measures (DDP and the two alcohol policy composite scales) are also shown in Table 1.

As seen, there is substantial variability in rates of alcohol-related injury and drinking patterns across studies. The percent of any drinking before injury ranged from 7.8% to 81.9% (mean = 28.3%; SD = 45.0%), while the proportion with BAC $\geq 0.08\%$ ranged from 0.5% to 46.9% (mean = 11.5%; SD = 31.9%), and the percent for causal attribution ranged from 1.7% to 42.3% (mean = 12.0%; SD = 32.5%).

Multi-level analysis predicting any drinking prior to injury

Table 2 shows estimates for the six models from 42 studies for predicting any drinking before injury. Gender and age were included in all models. Individual total volume of consumption (log-transformed and CWC), and drinking pattern, study-level average log volume of consumption, DDP, and the two alcohol policy composite measures were entered in the models.

The total volume individuals consumed in the last 12 months strongly predicted any drinking before injury (Model 1). When usual drinking pattern was used as the only predictor (Model 2), a partial step function was observed, with occasional light/non-heavy drinkers least likely to drink prior to injury, followed by occasional light/occasional heavy drinkers, frequent light/non-heavy and frequent light/occasional heavy drinkers, with frequent heavy drinkers most likely to report drinking before injury. This pattern effect on alcohol-related injury changed, however, after log volume of consumption was entered as a predictor of the random intercept (Model 3), with no significant difference between occasional light/non-heavy and frequent light/non-heavy drinkers. While frequent heavy drinkers were still most likely to drink before injury, a similar effect was also seen for occasional light/occasional heavy drinkers.

Study-level average log volume and DDP were next examined to predict cross-study variation in rates of any drinking before injury, together with individual volume of consumption as level-1 predictors (Model 4). Increasing aggregate average log volume was strongly related ($p < .01$), and increasing DDP marginally associated ($p < .10$), with increased odds of an alcohol-related injury. The effect of DDP was no longer marginally significant after individual drinking pattern was entered in the model (Model 5). Finally, neither of the two alcohol policy composite measures predicted cross-study variability in rates of drinking prior to injury (Model 6).

Multi-level analysis predicting BAC $\geq 0.08\%$ and causal attribution of injury to alcohol

For BAC $\geq 0.08\%$ and causal attribution outcome variables, the same models described above were fitted (Tables 3 and 4, respectively). The majority of results were similar to

those reported in Table 2. The difference in effects of drinking pattern were observed both before and after individual log volume of consumption was entered, and when both were entered, the two patterns showing the strongest relationship with either BAC 0.08% or causal attribution were infrequent light/occasional heavy and frequent heavy drinking. Also similar to Table 2, study-level average volume and DDP were significant predictors of cross-study variation in rates of both BAC 0.08% and causal attribution, but with the effect of DDP no longer significant after controlling for individual drinking pattern.

When comparing estimates predicting BAC 0.08% and causal attribution to those predicting any drinking prior to injury, one major difference was found. Alcohol policy related to driving significantly predicted both of these more restrictive measures of alcohol-related injury. Alcohol policy related to access also predicted causal attribution. Specifically, studies in countries or regions with a more restrictive policy were more likely to have lower rates of alcohol-related injury.

As noted above, multi-level analyses of the three measures of alcohol-related injury were based on slightly different studies due to the availability of data, with values for BAC and causal attribution measures missing for some studies. A sensitivity analysis was performed, repeating the analysis reported above, using only those studies having data for all three measures of alcohol-related injury, reducing the total number of studies to 32 with nearly all results similar to those previously discussed. One major difference was that study-level alcohol-related policy for driving was significantly associated with a diminished likelihood of any self-reported drinking prior to injury, suggesting that the non-significant finding in the main analysis on 42 studies, as shown in Table 2, may be due to study selection.

DISCUSSION

Large differences in drinking patterns were observed across studies. While an injury patient sample from an ED cannot represent the general population of the respective area, the observed differences between individual drinking patterns across countries appear to map well to known differences between countries or regional drinking patterns. For example, nearly half of the current drinkers in the Mexican samples reported infrequent heavy drinking, while the majority of patients from Ireland reported frequent heavy drinking, and frequent light drinking was the dominant pattern for the sample from Spain.

Individual usual drinking pattern

Total volume of alcohol consumed during the last year was predictive of an alcohol-related injury among injured patients for all three measures, and controlling for volume, individual drinking pattern was also significant, with episodic heavy and frequent heavy drinkers both having the greatest likelihood of an alcohol-related injury (research question 1). The elevated risk of heavy episodic drinkers for injury has been found elsewhere, with those who usually drink little but on occasion drink heavily at higher risk than other drinkers (5). In that study chronic heavy drinkers were at lower risk of injury, and the authors suggested this group of drinkers may have developed a higher tolerance to alcohol. It should be noted, however, that that study analyzed risk of injury, while the present study analyzed risk of an alcohol-related injury.

Regional DDP

DDP, as a predictor of alcohol-related injury among injured patients, was also analyzed before and after controlling for individual drinking pattern (research questions 2 and 3). Controlling for individual and study-level volume (Model 4), those regions with higher DDP were significantly ($p<0.05$) or marginally significantly ($p<0.10$) associated with higher rates

of alcohol-related injuries measured by all three indicators; however, DDP was not found to be significant when individual volume and pattern of drinking were controlled (Model 5), and occasional light/occasional heavy (episodic heavy) and frequent heavy drinkers continued to be at the highest risk for alcohol-related injury among injured patients. Episodic heavy drinking reflects the dominant drinking pattern in countries like Mexico (DDP=4, the most detrimental pattern), while frequent heavy drinking is more prevalent in countries like Ireland, South Africa and India (DDP= 3). The effect of volume-controlled individual drinking pattern is thus presumably similar to the aggregate-level DDP constructed at the country/regional level.

Regional alcohol policy

Controlling for aggregate-level consumption and DDP, alcohol policy related to driving was associated with a more restrictively defined alcohol-related injury measure (BAC 0.08% or causal attribution of injury to alcohol), but not significantly related to the more liberal definition of any self-reported drinking within six hours prior to the event (although the effect was in the same direction, and an association was found in sensitivity analyses) (research question 4). A more strict policy regarding legal intoxication level and DUI offense punishment might be expected to prevent individuals from becoming involved in risky behaviors while intoxicated (such as driving), but to have potentially less effect on deterring individuals from drinking moderate amounts of alcohol. Alcohol policy related to access was significantly predictive only of an individual's causal attribution of their injury to drinking, the most restrictive (and perhaps the most valid) of the definitions of alcohol-related injury used in these analyses. Earlier analysis found that legal level of intoxication (6) and legal drinking age (3) were both predictive of alcohol-related injury. The policy measures related to driving and access to alcohol analyzed here are composites developed to be more comprehensive than the individual items previously analyzed

Limitations—Self-reported consumption within six hours prior to the injury event and an elevated BAC do not necessarily capture the same time-frame in relation to the injury event. Both are affected by the length of time between injury and arrival in the ED, although this effect may be minimized in these analyses which only included those arriving within six hours following the injury event. BAC and self-report have not been found to be highly concordant in other ED studies (13), and large proportions who reported drinking register negative for estimated BAC (14). Self-reported drinking within six hours prior to injury likely over-represents alcohol-relatedness of the event, since a relatively small amount of alcohol consumed early in the six-hour period might have little to do with occurrence or causation of the injury.

The source population in this study is injured patients in the ED, and therefore findings only pertain to the risk of an alcohol-related injury among injured patients, and not to the risk of injury. Additionally, while patient samples in all studies were drawn to be representative of their respective EDs, these samples cannot be considered to be representative of a broader area. Analogously, while alcohol policy variables were collected to reflect the same time-period during which the respective ED data were collected, they may not adequately represent the geographic level relevant to the specific ED study, since they are generally based on aggregate-level statistics, ranging from regional- to country-level data.

Another limitation is the comparability of the measures used in this analysis across EDs, at both the individual and study levels. While countries have different (or no) definitions of a standard drink in terms of ethanol concentration, conversion was used in most studies so that the quantity measured in standard drinks was specified in local beverages and drink size. Therefore, drinking measures are not uniform across countries. The overall comparability

for individual consumption and pattern measures, however, is quite satisfactory, given the complexity involved in assessing drinking patterns across countries. Likewise, collection of information on relevant alcohol policies across countries and creating comparable categories is challenging, given the measures which were available.

Finally, the measure of individual drinking pattern, characterized by five mutually exclusive categories, may not fully capture the variations of usual drinking behaviors. For example, as weekly consumption was used as the cut-point for frequent vs. occasional drinking, those having 5+ drinks only once in the last year would fall into the same category of occasional heavy drinker as those having 5+ drinks twice a month. This suggests that the predictive power of the pattern variable might be improved in future studies, given larger numbers of patients across various drinking patterns.

Although data collection spanned a 25-year period (1984–2009), all data were collected using a comparable study design and collection procedures with nearly uniform rigor, and a similar questionnaire assuring comparability of items across studies. Given the diversity of the countries and areas within countries, as well as the relatively large and comparable samples across studies, findings here clearly point to the importance of an individual's drinking pattern in predicting the likelihood of an alcohol-related injury among injured patients. While the DDP level of a country is also a strong predictor of alcohol-related injury, it is no longer important when the individual volume and pattern of drinking is taken into account. Alcohol policy is also an important predictor of alcohol-related injury among injured patients, and while individual and societal drinking patterns may be difficult to influence by preventive measures aimed to reduce alcohol-related injury, alcohol control policy appears to be a fruitful area for future exploration.

Acknowledgments

The paper is based, in part on data collected by the following collaborators participating in the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP): Preben Bendtsen (Sweden), Guilherme Borges (Mexico), Won Cook (US), Mariana Cremonete (Argentina), Norman Giesbrecht (Canada), Gerhard Gmel (Switzerland), Ann Hope (Ireland), Scott Macdonald (Canada), Jacek Moskalewicz (Poland), Per Nilsen (Sweden), Juan Rhodes (Spain), Tim Stockwell (Canada), and Grazyna Swiathiewicz (Poland).

This paper is also based, in part, on the data and experience obtained during the participation of the authors in the WHO Collaborative Study on Alcohol and Injuries, sponsored by the World Health Organization and implemented by the WHO Collaborative Study Group on Alcohol and Injuries that includes: V. Benegal (India); G. Borges (Mexico); S. Casswell (New Zealand); C. Cherpitel (USA); M. Cremonete (Argentina); R. Evsegneev (Belarus); N. Figlie (Brazil); N. Giesbrecht (Canada); W. Hao (China); G. Humphrey (New Zealand); R. Larajeira (Brazil); S. Macdonald (Canada); S. Larsson (Sweden); S. Marais (South Africa); O. Neves (Mozambique); M. Peden (WHO, Switzerland); V. Poznyak (WHO, Switzerland); J. Rehm (Switzerland); R. Room (Sweden); H. Sovinova (Czech Republic); M. Stafstrom (Sweden). A list of other staff contributing to the project can be found in the Main Report of the Collaborative Study on Alcohol and Injuries, WHO, Geneva.

This paper is also based, in part, on the data obtained by the U.S. National Institute on Alcohol Abuse and Alcoholism and implemented by the following: Bridget Grant (NIAAA, USA), Patricia Chou (NIAAA, USA), Wei Hao (China), Sungsoo Chun (Korea).

The authors alone are responsible for views expressed in this paper, which do not necessarily represent those of the other investigators participating in the WHO Collaborative Study on Alcohol and Injuries nor the views or policy of the World Health Organization or of the U.S. National Institute on Alcohol Abuse and Alcoholism.

Supported by a grant from the U.S. National Institute on Alcohol Abuse and Alcoholism (RO1 2 AA013750-04)

References

1. Cherpitel CJ, Ye Y, Bond J. Alcohol and injury: multi-level analysis from the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP). *Alcohol and Alcoholism*. 2004; 39:552–558. [PubMed: 15351747]
2. Cherpitel CJ, Bond J, Ye Y. Alcohol and injury: a risk function analysis from the Emergency Room Collaborative Alcohol Analysis Project. *European Addiction Research*. 2006; 12:42–52. [PubMed: 16352902]
3. Cherpitel CJ, Bond J, Ye Y, Borges G, Macdonald S, Stockwell T, et al. Alcohol-related injury in the ER: a cross-national meta-analysis from the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP). *Journal of Studies on Alcohol*. 2003; 64:641–649. [PubMed: 14572186]
4. Watt K, Purdie DM, Roche AM, McClure RJ. Risk of injury from acute alcohol consumption and the influence of confounders. *Addiction*. 2004; 99:1262–1273. [PubMed: 15369564]
5. Gmel G, Bissery A, Gammeter R, Givel JC, Calmes JM, Yersin B, et al. Alcohol-attributable injuries in admissions to a Swiss Emergency Room — an analysis of the link between volume of drinking, drinking patterns, and preattendance drinking. *Alcoholism: Clinical and Experimental Research*. 2006; 30:501–509.
6. Cherpitel CJ, Ye Y, Bond J, Rehm J, Poznyak V, Macdonald S, et al. Multi-level analysis of alcohol-related injury among emergency department patients: a cross-national study. *Addiction*. 2005; 100:1840–1850. [PubMed: 16367985]
7. Cherpitel, CJ. A study of alcohol use and injuries among emergency room patients. In: Giesbrecht, N.; Gonzales, R.; Grant, M., et al., editors. *Drinking and Casualties: Accidents, poisonings and violence in an international perspective*. London; New York: Tavistock/Routledge; 1989. p. 288–299.
8. Cherpitel, CJ.; Ye, Y.; Bond, J.; Rehm, J.; Poznyak, V.; Macdonald, S., et al. Multi-level analysis of alcohol-related injury among emergency room patients: a cross-national study. *Research Society on Alcoholism*; Vancouver, BC, Canada. June 26–30; 2004. [Abstract: *Alcoholism: Clinical and Experimental Research* 2004;28(5):34A]
9. Rehm J, Monteiro M, Room R, Gmel G, Jernigan D, Frick U, et al. Steps towards constructing a global comparative risk analysis for alcohol consumption: determining indicators and empirical weights for patterns of drinking, deciding about theoretical minimum, and dealing with different consequences. *European Addiction Research*. 2001; 7:138–147. [PubMed: 11509844]
10. Rehm J, Rehn N, Room R, Monteiro M, Gmel G, Jernigan D, et al. The global distribution of average volume of alcohol consumption and patterns of drinking. *European Addiction Research*. 2003; 9:147–156. [PubMed: 12970583]
11. Raudenbush, SW.; Bryk, AS.; Congdon, RT, Jr. *HLM 6.02. Hierarchical Linear and Nonlinear Modeling*. Lincolnwood, IL: Scientific Software International; 2006.
12. Kreft IGG, De Leeuw J, Aiken LS. The effect of different forms of centering in hierarchical linear models. *Multivariate Behavioral Research*. 1995; 30:1–21.
13. Bond J, Ye Y, Cherpitel CJ, Room R, Rehm J, Borges G, et al. The relationship between self-reported drinking and BAC level in emergency room injury cases: is it a straight line? *Alcoholism: Clinical and Experimental Research*. 2010; 34:1118–1125.
14. Cherpitel CJS, Parés A, Rodés J, Rosovsky H. Validity of self-reported alcohol consumption in the emergency room: data from the United States, Mexico and Spain. *Journal of Studies on Alcohol*. 1992; 53:203–207. [PubMed: 1583899]

Alcohol-related injury among drinkers, drinking patterns, and contextual level variables across 46 ED Studies

Table 1

Studies and year ¹	Among drinkers %				Among drinkers % drinking pattern									
	Total N	Drinker%	Any use prior inj	BAC >=0.08	Causal Attribute	Infreq, No 5+	Freq, No 5+	Infreq, Infreq 5+	Freq, Infreq 5+	Freq 5+	DDP	Alc Pol Driving ²	Alc Pol Access ³	
Addiction. Author manuscript; available in PM 2013 July 11.														
Argentina														
Mar Del Plata 01 (E)	230	82.6	33.7	7.5	3.2	22.9	21.8	7.4	20.7	27.1	2	-1	0	
Mar Del Plata 01 (W)	452	83.8	25.3	10.1	10.3	30.0	18.1	12.6	21.3	17.9	2	-1	0	
Australia														
Fremantle 97 (E)	662	85.8	25.5	10.6	7.4	15.3	12.9	13.8	30.7	27.3	1	0	-1	
Belarus														
Minsk 01 (W)	457	88.0	34.1	28.0	10.4	27.9	3.2	32.6	24.1	12.2	3.6	NA	NA	
Brazil														
São Paulo 01 (W)	496	70.0	17.3	7.4	5.9	36.8	12.6	16.2	15.6	18.9	3	-1	0	
Canada														
Edmonton (Alberta) 89 (E)	173	88.4	34.6	22.6	8.5	32.0	4.6	28.1	12.4	22.9	3	-2	1	
Quebec city 89 (E)	143	90.9	13.8	5.3	3.8	34.4	10.2	25.0	25.8	4.7	1	-2	0	
Orangeville (ON) 92 (W)	222	80.8	7.8	1.1	2.6	30.1	17.1	16.1	28.0	8.8	2	2	2	
Vancouver 09 (E)	249	85.8	25.6	10.0	5.2	19.9	14.2	15.6	32.2	18.0	2	0	1	
China														
Changsha (Hunan) 01 (W)	533	41.1	45.8	7.0	19.0	19.9	9.0	33.2	11.4	26.5	2	-1	-4	
Beijing 09 (N)	500	68.4	21.0	2.8	10.7	35.0	10.9	23.4	18.2	12.5	2	2	-4	
Hangzhou (Zhejiang) 09 (N)	501	37.9	16.0	0.5	3.2	25.6	41.9	4.7	11.6	16.3	2	2	-3	
Chengdu (Sichuan) 09 (N)	500	86.2	21.9	17.2	5.3	32.4	6.8	30.2	19.8	10.8	2	2	-4	
Hengyang (Hunan) 09 (N)	508	78.3	30.2	15.8	10.8	19.4	2.2	36.9	17.0	24.5	2	2	-4	
Changsha (Hunan) 09 (N)	531	59.0	22.4	7.8	15.7	9.7	2.0	28.2	44.4	15.7	2	2	-4	
Czech Republic														
Prague 01 (W)	510	83.7	8.9	2.0	2.1	30.3	22.3	12.6	28.7	6.2	2	2	-2	
India														
Banglore 01 (W)	544	25.7	78.6	20.0	NA	5.8	31.2	3.6	13.0	46.4	3	2	4	

1. Addiction. Author manuscript; available in PMC 2013 July 1.

Studies and year ¹	Among drinkers %					Among drinkers % drinking pattern							
	Total N	Drinker%	Any use Prior inj	BAC >=0.08	Causal Attribute	Infreq, No 5+	Freq, No 5+	Infreq, Infreq 5+	Freq, Infreq 5+	Freq 5+	DDP	Alc Pol Driving ²	Alc Pol Access ³
Ireland													
Dublin 03–04 (E)	797	82.2	34.9	NA	21.5	5.1	8.0	10.7	14.4	61.8	3	–2	–1
Galway 03–04 (E)	405	83.0	23.5	NA	11.9	3.3	8.4	9.9	15.8	62.7	3	–2	–1
Letterkenny 03–04 (E)	177	70.5	33.9	NA	17.7	8.1	6.5	8.9	17.7	58.9	3	–2	–1
Sligo 03–04 (E)	182	81.9	28.9	NA	18.1	7.4	4.7	16.1	12.8	59.1	3	–2	–1
Waterford 03–04 (E)	525	78.4	20.2	NA	15.6	7.8	6.1	14.8	17.3	54.0	3	–2	–1
Korea													
Bucheon/Uijeongg 07 (N)	118	81.3	42.9	NA	26.4	26.7	2.2	25.6	5.6	40.0	3	1	–1
Seoul 09 (N)	514	66.2	22.0	8.7	9.0	45.4	8.4	17.3	5.1	23.9	3	1	–1
Suwon 09 (N)	485	79.0	32.6	15.6	19.7	24.3	1.6	21.4	12.7	39.9	3	1	–1
Chuncheon 09 (N)	466	77.2	32.5	9.0	24.3	17.5	6.6	13.2	10.0	52.7	3	1	–1
Donggu 09 (N)	524	85.1	34.9	11.1	23.4	7.8	0.9	39.9	10.3	41.0	3	1	–1
Mexico													
Mexico City 86 (E)	1,034	70.4	36.4	20.7	18.6	30.4	2.7	49.0	4.9	13.0	4	–3	–1
Acapulco 87 (E)	271	62.0	45.2	13.0	30.4	NA	NA	NA	NA	NA	4	–3	–1
Pachuca 96–97 (E)	486	48.0	26.1	7.2	11.4	29.5	1.5	53.7	4.8	10.5	4	–3	–3
Mexico City 02 (E)	456	83.3	24.8	11.3	9.0	39.5	1.3	44.0	4.5	10.7	4	–2	–1
Mozambique													
Mputo 01 (W)	459	60.6	28.0	18.0	7.7	9.9	12.9	33.1	14.8	29.3	3	NA	NA
New Zealand													
Auckland 00 (W)	153	97.2	45.1	17.6	16.3	15.4	8.1	28.9	23.8	23.9	2	NA	NA
Poland													
Warsaw 02 (E)	248	73.0	8.8	1.9	1.7	21.0	0.6	42.5	9.9	26.0	3	2	–3
Sosnowiec 03 (E)	294	84.1	19.8	7.3	3.7	23.6	2.1	40.1	15.7	18.6	4	2	–3
South Africa													
Cape Town 01 (W)	464	55.4	81.9	46.9	42.3	12.4	5.7	7.4	5.1	69.4	3	–3	–4
Spain													
Barcelona 87 (E)	933	91.0	22.0	8.0	3.3	36.0	54.1	0.2	6.4	3.3	1	–3	0

Author manuscript; available in PMC 2013 July 01.

Studies and year ¹	Among drinkers %					Among drinkers % drinking pattern							
	Total N	Drinker%	Any use Prior inj	BAC >=0.08	Causal Attribute	Infreq, No 5+	Freq, No 5+	Infreq, Infreq 5+	Freq, Infreq 5+	Freq 5+	DDP	Alc Pol Driving ²	Alc Pol Access ³
Sweden													
Malmö 01 (W)	497	87.9	17.0	4.6	5.0	34.4	18.9	22.7	17.4	6.7	3	2	0
Motala 07 (E)	281	89.9	13.2	NA	3.7	16.3	2.1	48.8	19.2	13.8	3	2	0
Switzerland													
Lausanne 06-07 (E)	325	93.2	27.0	10.7	10.7	24.2	11.1	21.1	28.2	15.4	1	1	0
The United States													
San Francisco (CA) 85 (E)	311	84.2	38.9	25.2	10.3	21.9	11.2	16.5	25.0	25.4	1	-3	1
Contra Costa (CA) 85 (E)	616	80.2	22.3	7.5	NA	29.1	11.9	14.8	29.1	15.2	1	-3	1
Contra Costa (CA) 87 (E)	406	84.5	25.9	10.2	NA	28.2	9.1	18.5	24.6	19.6	1	-3	1
Contra Costa (CA) 89 (E)	193	81.1	12.4	1.8	NA	36.7	17.0	12.4	25.5	8.3	1	-3	1
Jackson (MS) 92 (E)	141	73.8	38.5	11.0	8.7	35.9	17.5	12.6	11.7	22.3	3	-2	4
Santa Clara (CA) 95-96 (E)	152	73.5	24.8	10.8	9.9	29.5	1.8	19.7	27.9	21.0	1	-3	1

¹ (E): ERCAAP studies; (W): WHO collaborative studies; (N): NIAAA-funded studies;

² Combination of four policy measures: legal intoxication level for driving, random breath test, sanction on DUI and open container law, with higher value more restrictive policy control;

³ Combination of four policy measures: legal drinking age, off-premise sales restriction, bar open hours and sanctions serving minor, with higher value more restrictive policy control

Table 2

Odds Ratios (ORs) from hierarchical linear models predicting self-reported alcohol consumption before injury among current drinkers (42 studies ¹)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
N	12781	12834	12656	12781	12656	12656
Level 1 fixed effect ORs						
Men vs women	1.11	1.26**	1.04	1.11	1.04	1.04
Age 18–29 vs 30+	1.12 [†]	1.00	1.05	1.12 [†]	1.05	1.05
Alcohol volume last year ²	1.67***		1.58***	1.67***	1.60***	1.60***
Drinking pattern last year						
occasional light/non-heavy		0.27***	0.91		0.94	0.94
frequent light/non-heavy		Ref (OR=1)	Ref (OR=1)		Ref (OR=1)	Ref (OR=1)
occasional light/occasional heavy		0.87	1.65**		1.67***	1.67***
frequent light/occasional heavy		1.46***	1.23*		1.22*	1.22*
frequent heavy		3.00***	1.79***		1.75***	1.75***
Level 2 fixed effect ORs						
Study average volume ³				1.80**	1.72*	1.65*
Detrimental drinking pattern				1.15 [†]	1.08	1.13
Alcohol policy – driving ⁴						0.93
Alcohol policy – access ⁵						1.03
Level 2 variance⁶	0.684***	0.484***	0.637***	0.485***	0.494***	0.495***

¹ Belarus, Mozambique, and New Zealand were excluded as policy measures not available; Acapulco was excluded due to incomplete drinking pattern data

² Individual volume consumption (in 16ml standard drink, log-transformed) centered at study mean

³ Study mean of volume consumption (in 16ml standard drink, log-transformed)

⁴ Combination of four policy measures: legal intoxication level for driving, random breath test, sanctions on DUI, open container law (higher value more restrictive)

⁵ Combination of four policy measures: legal drinking age, off-premise sales restriction, bar open hours, sanctions serving minors (higher value more restrictive)

⁶ Chi-square test of variance larger than zero

[†] $p < 0.10$.

*
 $p < 0.05$,
 **
 $p < 0.01$,

 $p < 0.001$

et al.

Table 3

Odds Ratios (ORs) from hierarchical linear models predicting BAC 0.08% among current drinkers (36 studies)¹

N	Model 1 9767	Model 2 9791	Model 3 9647	Model 4 9767	Model 5 9647	Model 6 9647
Level 1 fixed effect ORs						
Men vs women	1.22	1.28*	1.12	1.21	1.11	1.11
Age 18–29 vs 30+	1.15	0.95	1.04	1.16	1.04	1.04
Alcohol volume last year ³	1.65***		1.51***	1.67***	1.52***	1.52***
Drinking pattern last year						
occasional light/non-heavy		0.44***	1.32		1.36	1.35
frequent light/non-heavy		Ref (OR=1)	Ref (OR=1)		Ref (OR=1)	Ref (OR=1)
occasional light/occasional heavy		2.16**	3.56***		3.60***	3.60***
frequent light/occasional heavy		2.86**	2.36**		2.34**	2.36**
frequent heavy		6.89***	4.06***		3.94***	3.97***
Level 2 fixed effect ORs						
Study average volume ³				1.99**	1.80*	1.93***
Detrimental drinking pattern				1.27*	1.16	1.23**
Alcohol policy – driving ⁴						0.82**
Alcohol policy – access ⁵						0.96
Level 2 variance⁶	0.818***	0.571***	0.672***	0.630***	0.568***	0.447***

¹ 4 studies were excluded as in Table 1; another 6 studies (5 in Ireland and Sweden Motala) were excluded as BAC was either not measured or invalid

² Individual volume consumption (in 16ml standard drink, log-transformed) centered at study mean

³ Study mean of volume consumption (in 16ml standard drink, log-transformed)

⁴ Combination of four policy measures: legal intoxication level for driving, random breath test, sanctions on DUI, open container law (higher value more restrictive)

⁵ Combination of four policy measures: legal drinking age, off-premise sales restriction, bar open hours, sanctions serving minors (higher value more restrictive)

⁶ Chi-square test of variance larger than zero

* $p < 0.10$,

*
 $p<0.05$,
**
 $p<0.01$,

 $p<0.001$

et al.

Table 4

Odds Ratios (ORs) from hierarchical linear models predicting causal attribution among current drinkers who reported drinking (38 studies^{1/})

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
N	11690	11718	11567	11690	11567	11567
Level 1 fixed effect ORs						
Men vs women	0.98	1.08	0.90	0.98	0.90	0.90
Age 18–29 vs 30+	1.08	0.93	1.01	1.08	1.00	1.00
Alcohol volume last year ²	1.65***		1.54***	1.65***	1.57***	1.57***
Drinking pattern last year						
occasional light/non-heavy		0.38***	1.16		1.21	1.21
frequent light/non-heavy		Ref (OR=1)	Ref (OR=1)		Ref (OR=1)	Ref (OR=1)
occasional light/occasional heavy		1.46 [†]	2.61***		2.64***	2.64***
frequent light/occasional heavy		1.70**	1.40 [†]		1.39 [†]	1.39 [†]
frequent heavy		4.57***	2.75***		2.64***	2.64***
Level 2 fixed effect ORs						
Study average volume ³				1.93***	1.77***	1.62***
Detrimental drinking pattern				1.32*	1.20	1.14
Alcohol policy – driving ⁴						0.90*
Alcohol policy – access ⁵						0.90*
Level 2 variance⁶	0.803***	0.421***	0.620***	0.507***	0.433***	0.407***

^{1/} 4 studies were excluded as in Table 1; another 4 studies (Contra Costa 85, 87 and 89 and India WHO) were excluded as the causal attribution question was either asked only for those reporting being drunk or not asked

^{2/} Individual volume consumption (in 16ml standard drink, log-transformed) centered at study mean

^{3/} Study mean of volume consumption (in 16ml standard drink, log-transformed)

^{4/} Combination of four policy measures: legal intoxication level for driving, random breath test, sanctions on DUI, open container law (higher value more restrictive)

^{5/} Combination of four policy measures: legal drinking age, off-premise sales restriction, bar open hours, sanctions serving minors (higher value more restrictive)

^{6/} Chi-square test of variance larger than zero

[†] $p < 0.10$,

et al.

$p<0.001$

$p<0.01$,

**

$p<0.05$,

*